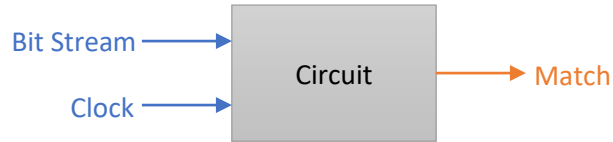# Design of Sequential Circuits I

Please do the following exercises individually.

Bit sequences

Please design a sequential circuit which finds three subsequent *0*s in a bit stream.

A bit stream is a sequence of bits controlled by a clock signal.

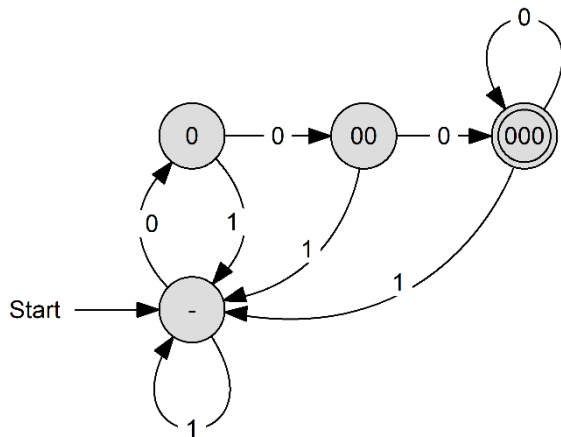The circuit should read the input stream and output a *1* if pattern *000* is found.

Design of Sequential Circuits I

Please do the following exercises individually.

Bit sequences

Please design a sequential circuit which finds three subsequent 0s in a bit stream.
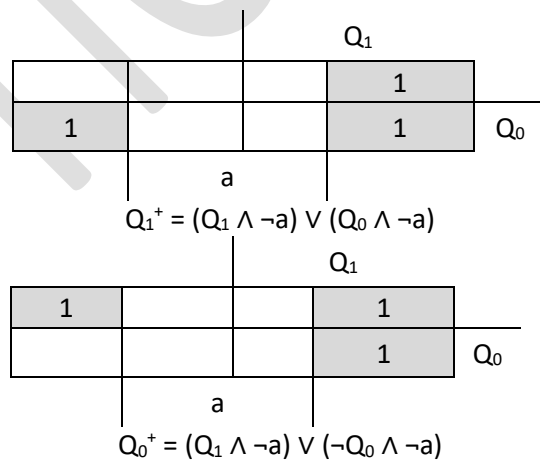
State machine and encoding

State	Encoding	
-	0_{dec}	00_{bin}
0	1_{dec}	01_{bin}
00	2_{dec}	10_{bin}
000	3_{dec}	11_{bin}

Two D flip-flops necessary

Control logic

Q_1	Q_0	a	Q_1^+	Q_0^+
0	0	0	0	1
0	0	1	0	0
0	1	0	1	0
0	1	1	0	0
1	0	0	1	1
1	0	1	0	0
1	1	0	1	1
1	1	1	0	0

$$Q_1^+ = (Q_1 \wedge \neg a) \vee (Q_0 \wedge \neg a)$$

$$Q_0^+ = (Q_1 \wedge \neg a) \vee (\neg Q_0 \wedge \neg a)$$

Output logic and circuit

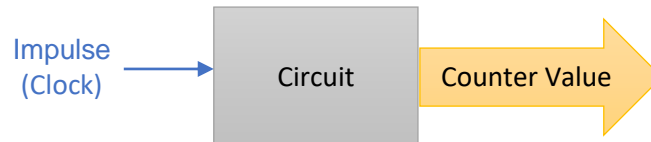| Q_1	Q_0	y
0	0	0
0	1	0
1	0	0
1	1	1
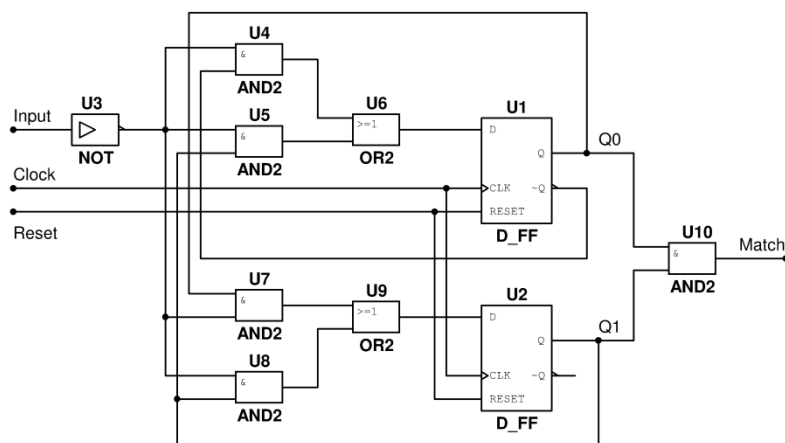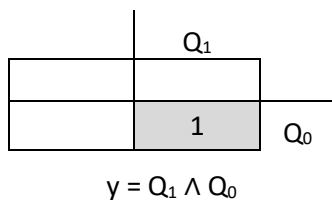
$$y = Q_1 \wedge Q_0$$

Design of Sequential Circuits II

Please do the following exercises individually.

Counter

Please design a mod-6 counter.

A counter counts impulses. These impulses are produced by the events which should be counted. A person triggers for example a light barrier when he or she enters a room. We want to know how many persons entered the room.

Counters have a certain range. Most counters restart from 0 when an overflow occurs. So if the range of a counter is 0 … 5 the it counts 0, 1, 2, 3, 4, 5, 0, 1, …. Such a counter is called mod-6 counter.
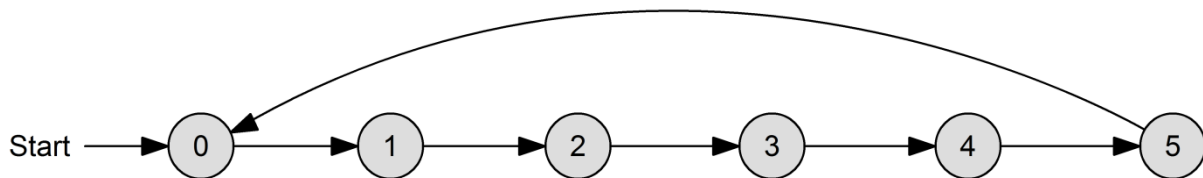
Design of Sequential Circuits II

Please do the following exercises individually.

Counter

Please design a mod-6 counter.

State machine

State encoding and output logic

State	0	1	2	3	4	5
Encoding	000	001	010	011	100	101

Three D flip-flops necessary
No output logic necessary

Control logic and circuit

n	Q_2	Q_1	Q_0	Q_2^+	Q_1^+	Q_0^+
0	0	0	0	0	0	1
1	0	0	1	0	1	0
2	0	1	0	0	1	1
3	0	1	1	1	0	0
4	1	0	0	1	0	1
5	1	0	1	0	0	0
6	1	1	0	X	X	X
7	1	1	1	X	X	X

$Q_2^+ = (Q_1 \wedge Q_0) \vee (Q_2 \wedge \neg Q_0)$

$Q_1^+ = (\neg Q_2 \wedge \neg Q_1 \wedge Q_0) \vee (Q_1 \wedge \neg Q_0)$

$Q_0^+ = \neg Q_0$